BRAZED CERAMIC SEAL FOR BATTERIES WITH TITANIUM-TITANIUM-6Al-4V CASES

FIELD OF THE INVENTION

This invention relates to brazed ceramic seals for use in lithium ion batteries.

BACKGROUND OF THE INVENTION

A chemical battery case may act to prevent the positive and negative output devices from coming into contact, i.e., shorting. The battery case in its entirety also functions to contain and prevent leakage of battery materials such as an electrolyte. Moreover, the battery case itself must provide for mechanical strength to contain pressures originating from within the battery as well as to provide the mechanical strength for ordinary handling of the battery.

SUMMARY OF THE INVENTION

The invention includes a brazed ceramic ring that separates the positive and negative ends of the battery while still providing a leak-tight seal. The ceramic is aluminum oxide or zirconium oxide or zirconium oxide with 3% yttrium. The invention includes a brazing material, which is greater than 50% gold. The invention includes a titanium alloy case (Ti-6Al-4V) which is titanium with 6% aluminum and 4% vanadium as its major alloying elements. The case has the desirable properties of titanium such as high strength for a relatively low weight; and the case has the requisite ability and electro-activity to be used a positive current carrying element where the battery's positive electrode exhibits more than 3.5 V vs. Li/Li^+.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other features and advantages of the invention will be more apparent from the following detailed description wherein:

Figure 1 shows the titanium alloy battery case with titanium and titanium alloy end caps and the ceramic non-conducting ring;

Figure 2 shows the ceramic ring sandwich with the ceramic ring between a ring of Ti and between a different ring of Ti-6Al-4V, and the gold-based braze.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The following description is of the best mode presently contemplated for carrying out the invention. This description is not to be taken in a limiting sense, but is merely made for the purpose of describing the general principles of the invention. The scope of the invention should be determined with reference to the claims.

The battery (1), as shown in Figure 1, is constructed of a titanium alloy case (2), the alloy being Ti-6Al-4V. This alloy is principally titanium with 6% aluminum and 4% vanadium, with oxygen, nitrogen, carbon, hydrogen and iron typically present as trace elements. One end cap (3), which completes the bottom of the positive casing, is also of the titanium alloy Ti-6Al-4V. The ceramic ring sandwich (20) is shown in Figures 1 and 2. First looking at Figure 2, the ceramic ring (21) is brazed by the gold alloy braze (24) to a one ring of titanium (23) and the other ring of Ti-6Al-4V. (22). The gold alloy braze (24) is one which contains more than 50% gold by weight. A specific type of gold alloy braze (24) is 96.4% gold, 3.0% nickel and 0.6% titanium. Some trace elements may be present with a corresponding slight adjustment in the composition percentages. The braze is chosen so that it can stand up to the electrochemical conditions inside the battery with which it will come in contact. The ceramic ring (21) is of aluminum oxide, zirconium oxide or zirconium oxide with 3% yttrium.

Returning to Figure 1, the ceramic ring sandwich (20) is placed on the open end of the titanium alloy case (2) with the titanium alloy ring (22) toward the case (2). The titanium ally ring (22) is then laser welded to the titanium alloy case (2). Subsequently a titanium end cap (4) with a feed-though hole (5) is laser welded to the titanium ring (23) of the ceramic ring sandwich (20).

In order to prevent any short-circuiting by way of the ceramic ring (21), it must be at least 10 μm in height (25). This arises from any diffusion of the gold alloy braze material (24) through the ceramic ring (21). Additionally, the height (27) of the titanium and the height (26) of the titanium alloy rings must be at least 30 μm. This is so that the gold alloy braze will not re-melt when the Ti and Ti-6Al-4V rings are laser welded.

Methods of assembly for the ceramic ring sandwich (20) include brazing together a sheet of ceramic material between a sheet of titanium and titanium alloy (Ti-6Al-4V) and then laser cutting a shape to fit the end of a given battery case. The

sandwich can be cut into almost any desired geometrical shape. Another method is cutting out the ceramic ring (21) and the titanium alloy (Ti-6Al-4V) ring (22) and the titanium ring (23) separately and brazing the pieces together.

The titanium alloy (Ti-6Al-4V) case (2) has the desirable properties of titanium such as high strength for a relatively low weight; and the case has the requisite ability and electro-activity to be used a positive current carrying element where a battery's positive electrode exhibits more than 3.5 V vs. Li/Li^+.

Typically, once the ceramic sandwich (20) is welded to the battery case (1), the battery electrodes (not shown) can be inserted into the case (2) and the feedthrough pin (not shown) inserted through the hole (5) in the lid (4). The feedthrough pin (not shown) is welded shut to provide a leak-tight seal. The battery (1) is filled with electrolyte (not shown) and laser welded closed on the bottom end (3). Tabs (not shown) which are connected to the positive electrode (not shown), can be folded out of the case (2) and laser welded at the same time as the bottom end cap (3).

While the invention herein disclosed has been described by means of specific embodiments and applications thereof, numerous modifications and variations could be made thereto by those skilled in the art without departing from the scope of the invention set forth in the claims.